Characteristics of bird communities between slope and valley in natural deciduous forest, South Korea

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Abstract: Bird communities were surveyed in natural deciduous forest of both slope area and valley area at Mt. Gyebangsan (37°40' 30" N, 128°30' 1" E), Gangwon Province, South Korea in winter, spring, summer and autumn from September 2000 to November 2001. The investigating results showed that there existed differences in the bird species composition, richness, bird species diversity, guild structure between slope area and valley area, and the vertical forest structure, especially coverage of understory, and diameter at breast height (DBH) distribution also had significant difference between the two study areas. The differences in habitat structure between the areas are very likely to have influences on how birds used the available habitat.
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Introduction

The question of what components of habitat determine bird community patterns has attracted many researchers' attention during several decades. The relationships between bird communities and habitat structure have been studied (Hino 1985). The structure and functioning of a biological community are affected by the characteristics and interactions of its constituent species (Holmes *et al.* 1979). Community diversity can be examined by noting the number of species within a single habitat (alpha-diversity), the changes in species composition along a series of habitats (beta-diversity), or the total species richness of a large geographic region (gamma-diversity; Short 1979). The diversity of birds in a community is closely related to the structure of vegetation (Roth 1976).

Habitat selection by breeding forest birds is largely dependent on habitat structure (Anderson *et al.* 1974; Crawford *et al.* 1981). The general term "habitat structure" contains elements of forest age, diameter at breast height (DBH) distribution, vegetation structure, stocking and forest type. In many studies on forest bird habitat associations, stand age, plant species composition and other within-stand features are variously used to describe forest structure (MacArthur *et al.* 1961; Karr *et al.* 1971; Erdelen 1984; Hino 1985; Lee 1996; Rhim *et al.* 2000).

This study was to clarify the characteristics of bird communities between slope and valley with respect to bird species' richness, density, diversity, guild structure and habitat structure in natural deciduous forest, South Korea.

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Methods

This study was conducted in natural deciduous forest at Gyebangsan (37°40' 30" N, 128°30' 1" E), Gangwon Province, South Korea. The dominant species growing within the study area were oaks genus *Quercus*, such as *Q. mongolica*, *Q. dentata* and *Q. serrata*. Two kilometer line transects were selected in slope and valley areas for the census of bird community.

In order to describe quantitatively the habitat, variables of the forest structure, such as vertical foliage profile, DBH and tree species were recorded in the areas of woodland with five meters in diameter along the survey route. Totally 20 such areas were selected in slope and valley areas. Vegetation surveys were carried out in late August 2001.

Vertical foliage profile was classified into six layers. The high canopy layer was at 10-16 m above the ground, the mid-canopy layer was at 6-10 m, the low canopy layer at 2-6 m, the understory layer at 1-2 m above the ground, and the ground-bush layer was less than a meter high (Rhim 1997).

Numeric values 0, 1, 2, 3 were assigned to percentages of foliage cover to represent a foliage cover of 0, 1%-33%, 34%-66%, and 67%-100%, respectively (Lee 1996). The dominant herbs, bushes and all trees were identified and counted within each sample area. DBH was measured for all trees exceeding 6 cm in DBH.

Bird communities were surveyed in winter, spring, summer and autumn from September 2000 to November 2001. In both slope area and valley area, four censuses were conducted by line transect method. Bird species diversity (Shannon *et al.* 1949) and guild structure (Root 1967) were used in the analysis of breeding bird communities. According to the survey results of nesting and foraging behaviors

of breeding species in the study area, the breeding bird community was classified into the nesting and foraging guild by using Happanen's criteria (1965). The nesting guild was divided into canopy, hole and bush, and the foraging guild was separated into canopy and bush (Table 1).

Bird species diversity (BSD, H') values were calculated by the following equation (Shannon *et al.* 1949):

$$H' = \sum_{i=1}^{s} (-p_i) \times \ln(p_i) \quad (1)$$

Where s is the number of categories and P_i is the proportion of individuals in the i th category.

Table 1. Category of nesting and foraging guilds

Guild	Nesting or foraging site	Abbreviation
Nesting		
Canopy	Canopy	C
Hole	Tree hole	H
Bush	Bush, ground	B
Foraging		
Canopy	Leaf, twig, branch, trunk, bud	c
Bush	Vine, litter, bush, fallen log, ground	b
Outside	Outside of forest	o

Results and discussion

The average foliage profiles had differences in understory (1-2m high) layer and ground-bush (<1 m high) layers (t-test; understory layer: t= 3.58, p<0.05; ground-bush layer: t=2.14, p<0.01) between the slope area and valley area. In valley area, the understory vegetation had developed in response to the increased amount of sunlight reaching the ground. The coverage of other vertical layers between two study areas had no differences (Fig. 1).

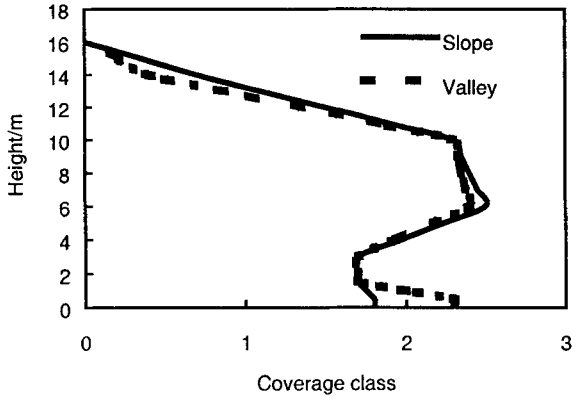

Fig. 1 Average foliage profiles in slope and valley areas at natural deciduous forest of Mt. Gyebangsan, South Korea

The DBH distribution was different between slope and valley areas. There were smaller size trees (<DBH 20 cm) distributed in slope area than in valley area, but middle size trees (DBH 20-30 cm) were more in valley area than in slope area. The quantities of larger size trees (> DBH 30 cm) were same for the two study areas (Fig. 2).

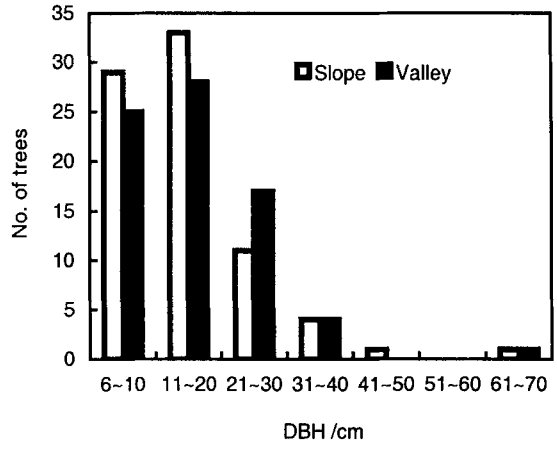

Fig. 2 DBH distributions in slope and valley areas at natural deciduous forest of Mt. Gyebangsan, South Korea

Twenty individuals of 9 birds species were observed in slope area and 22 individuals of 8 birds species, were in valley area in winter. Japanese pygmy woodpecker *Dendrocopos kizuki*, marsh tit *Paurs palustris*, major tit *Parus major*, varied tit *Parus varius* and bullfinch *Pyrrhula pyrrhula* were commonly recorded in both areas. Bird species diversity (H') was higher in slope area than that in valley area (Table 2). The groups of birds containing of those species were observed in this season.

Table 2. Differences in bird community between slope area and valley area in winter

Scientific name	Slope area	Valley area
Bonasa bonasia	2	-
Dendrocopos kizuki	2	1
Hypsipetes amaurotis	2	-
Phoenicurus auroreus	-	1
Parus palustris	4	2
Parus major	1	4
Parus varius	2	2
Sitta uropaea	2	-
Fringilla montifringilla	-	1
Pyrrhula pyrrhula	3	9
Eophona migratoria	-	2
Garrulus grandarius	2	-
No. of species	9	8
No. of individuals	20	22
H'	2.14	1.75

Forty-eight individuals of birds, of 21 species, were recorded in slope area. Among 53 individuals of birds, 21 species were in valley area in spring. Arctic warbler *Phylloscopus borealis* was dominant species in both areas. Bird species diversity was higher in slope area than that in valley area. Hazel grouse (*Bonasa bonasia*), Eurasian eagle

owl (*Bubo bubo*), Grey-headed woodpecker (*Picus canus*), Siberian thrush (*Zoothera sibirica*), varied tit and Eurasian nuthatch (*Sitta europaea*) were observed only in slope area (Table 3). There were more forest preferred bird species in slope area than in valley area. However, brown dipper (*Cinclus pallasii*) and blue-and-white flycatcher (*Cyanoptila cyanomelana*), which inhabit near stream, were recorded in valley area.

Table 3. Differences in spring bird communities between slope and valley areas of Mt. Gyebangsan, South Korea

Scientific name	Guild		Slope	Valley	Mig. [3]
	N [1]	F [2]			
Bonasa bonasia	B	c	2	-	Res.
Cuculus fugax	* [4]	*	1	1	S.V.
Cuculus micropterus	*	*	1	1	S.V.
Cuculus saturatus	*	*	2	2	S.V.
Bubo bubo	*	*	1	-	Res.
Dendrocopos kizuki	H	c	3	1	Res.
Picus canus	H	c	1	-	Res.
Cinclus pallasii	*	*	-	1	Res.
Troglodytes troglodytes	B	b	2	2	Res.
Luscinia sibilans	B	b	-	1	P.M.
Luscinia cyane	B	b	3	1	S.V.
Zoothera sibirica	B	b	1	-	P.M.
Zoothera dauma	B	b	-	1	S.V.
Turdus pallidus	B	b	2	2	Res.
Urosphena squameiceps	B	b	3	2	S.V.
Phylloscopus brealis	B	b	5	14	S.V.
Phylloscopus coronatus	C	c	3	9	S.V.
Cyanoptila cyanomelana	C	c	-	2	S.V.
Aegithalos caudatus	C	c	4	3	Res.
Parus plustris	H	c	4	2	Res.
Parus ater	H	c	3	2	Res.
Parus major	H	c	-	2	Res.
Parus varius	H	c	3	-	Res.
Sitta uropaea	H	c	2	-	Res.
Emberiza elegans	B	b	1	2	Res.
Garrulus grandarius	C	c	1	1	Res.
Corvus macrorhynchos	C	c	-	1	Res.
No. of species			21	21	
No. of individuals			48	53	
H'			2.92	2.60	

Notes: [1] N – nesting guild, H – hole, C – canopy, B – bush; [2] F – foraging guild, c – canopy, b – bush; [3] Mig. – migration, Res. – residents, S.V. – summer visitors, P.M. – passage migrants; [4] * – This birds were omitted for characterization of guild because of the peculiarity of breeding habits.

The number of species and pairs of canopy nesting guilds were much greater in valley area than those in slope area. However, the number of hole nesting guild members was smaller in valley area than that in slope area. As the increase of understory coverage (Fig. 1), birds belong to bush nesting and foraging guilds, such as Arctic warbler and eastern crowned willow warbler (*Phylloscopus coronatus*), were more in valley area than in slope area (Table 4). There were differences in species compositions of both study areas with different habitat structure (Rhim *et al.* 2000). In valley area, there were more birds foraged and nested either on the ground or in the bush layer, where there was suitable habitat available.

Table 4. Differences in guild structure of breeding bird community between slope and valley areas of Mt. Gyebangsan, South Korea

Guild	Slope area	Valley area
Canopy nesting guild	3(8)*	5(16)
Hole nesting guild	6(16)	4(7)
Bush nesting guild	8(19)	8(25)
Canopy foraging guild	10(26)	9(23)
Bush foraging guild	7(17)	8(25)

Notes: *----The number outside the bracket means no. of species, and the number inside the bracket means no. of individuals.

Eurasian nuthatch, hazel grouse and marsh tit were dominant in slope, and major tit, Eurasian nuthatch and Arctic warbler were in valley in summer. Bird species diversity was higher in valley area than in slope area. Hazel grouse, marsh tit, major tit and Eurasian nuthatch were observed in both study areas (Table 5).

Table 5. Differences in summer bird community between slope and valley areas of Mt. Gyebangsan, South Korea

Scientific name	Slope area	Valley area
Butorides striatus	-	1
Bonasa bonasia	6	3
Streptopelia orientalis	-	1
Dendrocopos kizuki	2	-
Dendrocopos leucotos	1	-
Anthus hodgsoni	-	1
Cinclus pallasii	-	2
Turdus pallidus	3	-
Paradoxornis webbianus	-	4
Cettia diphone	-	5
Phylloscopus borealis	4	-
Phylloscopus coronatus	-	8
Parus varius	-	1
Parus palustris	6	6
Parus ater	1	-
Parus major	2	11
Sitta uropaea	8	9
Emberiza elegans	-	2
Emberiza spodocephala	-	1
Garrulus grandarius	-	2
No. of species	9	15
No. of individuals	33	57
H'	1.99	2.38

Table 6. Difference in autumn bird community between slope and valley areas of Mt. Gyebansan, South Korea

Scientific name	Slope area	Valley area
Buteo buteo	-	1
Dendrocopos kizuki	2	-
Dendrocopos leucotos	2	-
Dendrocopos major	1	-
Hypsipetes amaurotis	2	-
Aegithalos caudatus	5	-
Parus varius	5	-
Parus palustris	11	3
Parus major	-	4
Sitta uropaea	8	3
Emberiza elegans	-	8
Carpordacus roseus	-	5
No. of species	8	6
No. of individuals	36	24
H'	1.83	1.64

Among thirty-six individuals of birds, 8 species were observed in slope area. Among 24 individuals of birds, 6 species were in valley area in autumn. Just only marsh tit and Eurasian nuthatch were commonly recorded in both areas. Marsh tit and Eurasian nuthatch were dominant in slope area, and yellow-throated bunting (*Emberiza elegans*), pallas's rosefinch (*Carpodacus roseus*) and major tit were in valley area (Table 6).

The bird species composition, richness, bird species diversity, guild structure were different between study areas. The vertical forest structure, especially coverage of understory and DBH distribution also differed in two study areas. The differences in habitat structure between the areas are very likely to have influences on how birds use the available habitat (Lee 1996; Rhim *et al.* 2000).

Number of species and individuals, and bird species diversity index of spring bird community was highest among the 4 seasons. Birds are the most active in mating, feeding for chicks in spring (Keast 1990). For this reason, spring bird community was more abundant than that of other seasons (Lee *et al.* 1999).

Many environmental factors influence the structure of forest bird communities. Population dynamics and ecology would be strongly associated with differences in habitats (Sabo *et al.* 1983). For forest birds, their habitat feature is most likely to affect the searching and prey-attacking behavior. Vegetation structure is important because it affects how birds more through the habitat and how they can see and capture prey (Robinson *et al.* 1982).

The high taxonomic and structural diversity of forest ecosystem provide an opportunity for maximum bird species diversity and system stability (Lee 1996). Greater structural complexity offers a greater variety of foraging opportunities for birds within forest areas (Karr *et al.* 1971; Rhim 1997).

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